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Supply Impact Analysis of the Smith-Jeffords Bill

There are four primary provisions in the Smith-Jeffords bill that could have an impact on gasoline supply in the U.S. These include the nationwide ban on MTBE, rescinding the 1 psi RVP waiver for ethanol blended into conventional gasoline, the additional air toxics requirements, and the provision of grant money to support the conversion of merchant MTBE plants to the production of other gasoline blendstocks. The impact of each of these provisions is discussed below. The evaluation of the support for the conversion of merchant MTBE plants to the production of other gasoline blendstocks is combined with that of the ban on MTBE use.

A. Nationwide MTBE Ban

Due to the attention that has been place on the MTBE issue over the last several years, there have been a number of different MTBE ban scenarios that have been put forward and a considerable amount of analysis already performed for at least some scenarios. Differences in how the bans would be implemented, however, can cause significant differences in what impact they will have on the gasoline fuel supply. What follows is a summary of an analysis EPA conducted for a nationwide ban on MTBE use which mirrors relatively closely the MTBE ban provisions in the Smith-Jeffords Bill. Where there are differences in the Bill we have tried to highlight how that might change the results.

Table A-1 shows the sources of the MTBE used in U.S. gasoline and estimated 2000 production volumes (from Pace Consultants[1]). The total MTBE volume of 263,000 bbl/day represents approximately 3.1% of U.S. gasoline consumption. However, since MTBE contains only about 80% of the energy density of gasoline, its use leads to somewhat less fuel economy. Consequently, on a energy equivalent basis this MTBE volume represents approximately 2.5% of total U.S. gasoline consumption. More recent figures from EIA project total MTBE volume and domestic production to both be slightly lower for 2001. Since the differences are small and 2001 data are not yet complete, however, this analysis will continue to use the year 2000 data.

Table A-1: Year 2000 Production Volume of MTBE (barrels/day) in the U.S.

Type of MTBE Plant	Physical Volume	Gasoline Equivalent Volume
Captive refinery plants	79,000	64,000
Propylene Oxide based merchant plants	45,000	36,000
Ethylene based merchant plants	21,000	17,000
Natural gas liquids (NGL) based plants	67,000	54,000
Imports (NGL based)	51,000	41,000
Total	263,000	212,000

In support of EPA's analysis of restrictions on the use of MTBE under the Toxic Substances and Control Act, we hired Pace Consultants, a knowledgeable and reputable firm, to conduct an analysis of the economics of converting all of the different types of MTBE plants to produce either alkylate or iso-octane versus completely shutting down.

MTBE plants react isobutylene with methanol to make MTBE. MTBE plants fall into two broad categories: those which use isobutylene which already exists and those which have to produce isobutylene from other chemicals. Captive or refinery based MTBE plants and ethylene based MTBE plants fall into the first category, as their isobutylene is being produced in the process of making gasoline in the refinery or butadiene in the chemical plant.

Domestic and overseas NGL based MTBE plants fall into the latter category. These plants produce isobutylene via three processes from a mixture of normal butane and isobutane obtained from natural gas processing. Propylene oxide based MTBE plants fall into the second category, strictly speaking, as they produce isobutylene from tertiary butyl alcohol. However, practically, they fall into the first category, as they can produce isobutylene via one inexpensive chemical process. This distinction is relevant, because the less costly the isobutylene, the more likely it will be converted to either iso-octane or alkylate.

If an MTBE plant converts to alkylate production, it produces 80% more gasoline in terms of energy content than it did when producing MTBE. The gain in energy comes from the fact that isobutane is combined with this isobutylene in the production of alkylate, versus the addition of methanol in the production of MTBE. Isobutane contains more energy than methanol, so the product does as well.

If an MTBE plant converts to iso-octane production, it produces 15% less gasoline equivalent volume than it did when producing MTBE. Again, this assumes that the converted MTBE plant would process the same amount of isobutylene as before. The loss in energy comes from the fact that isobutylene is reacted with itself to form iso-octane (i.e., no other feedstock is combined with the isobutylene in the reaction). Thus, the energy content of methanol is lost relative to MTBE production.

Alkylate and iso-octane both contain no aromatics and have relatively high octane (90-100) and low RVP. These properties make these blendstocks good, but not perfect, substitutes for MTBE. Their low RVP also make it relatively easy to add ethanol to RFG and still meet the Phase 2 RFG VOC performance standards. The Pace study found that it should be economic for the vast majority of MTBE production to be converted to either iso-octane or alkylate production. Below, we discuss the likely fate of each type of MTBE plant, plus imports.

Pace projected that captive, refinery MTBE plants will likely convert to either iso-octane or that the isobutylene will be used to produce alkylate in refiners' existing alkylation plants. Isobutylene was always converted to alkylate prior to MTBE production and this would be the preferred route now, due to the higher volume of gasoline produced with alkylate versus iso-octane. However, if a refiner's current alkylation unit did not have excess capacity or its capacity could not be inexpensively increased, Pace concluded that the MTBE unit would likely be converted to iso-octane. Thus, as a lower limit for our analysis we have presumed that the all these MTBE units are converted to produce iso-octane, and as an upper limit all the isobutylene will be used to produce alkylate. However, in no case should the MTBE production from these plants be completely lost as the isobutylene is available at no cost and has no other high value market.

Pace projected that propylene oxide based MTBE plants are likely to convert to iso-octane production, due to the lower capital cost involved.[1] Like captive, refinery plants, these plants are unlikely to shut down, since the feedstock used to produce MTBE (tertiary butyl alcohol) is produced as a by-product from propylene oxide or ethylene production and does not have (i.e., it is essentially free).

Pace projected that ethylene based MTBE plants are likely to shutdown and send their isobutylene to refineries for conversion to alkylate. Thus, while the MTBE plant itself is shut down, the volume it produces is not lost. As a lower limit, we projected that these ethylene based plants would convert to iso-octane, like the propylene oxide based plants

Pace projected that merchant, natural gas liquids (NGL) based MTBE plants would face the greatest challenge to stay in business. If they were to stay in business, Pace projected that they would be more likely to convert to alkylate than iso-octane production. Historical alkylate price premiums over premium gasoline would not support conversion to alkylate production. However, this year price premiums have been consistently higher. Furthermore, under ~~a partial or~~ complete MTBE ban, demand for clean high-octane blending components should increase and alkylate price premiums should increase accordingly. This was in fact the case in all refining studies of California under their MTBE ban which showed significant flows of alkylate from the Gulf Coast to California. Consequently, for this analysis of a nationwide MTBE ban, due to the uncertainty, we have projected in the worst case that all of these plants would shut down or in the best case that all would convert to alkylate production. Under the actual provisions in the Smith-Jeffords Bill, the best case is most likely to occur. This is due to the $750 million it would provide to help convert MTBE plants. While beneficial to all types of MTBE plants, it would be of most benefit to the merchant plants to ensure that their volume remains in the gasoline supply.

Finally, Pace projects that most foreign natural gas based MTBE plants are likely to convert to iso-octane production, given their low feedstock costs. This was observed already with an MTBE plane up in Alberta, Canada.

Table A-2 summarizes the results of this analysis. As can be seen, the net impact ranges

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[1] Pace estimates that it would cost $30 million to convert a 15,000 bbl/day MTBE plant to iso-octane production and $60 million to convert to alkylate production.

from a loss of approximately 84,000 bbl/day to a gain of approximately 91,000 bbl/day, or roughly a gain or loss of approximately 1% of total nationwide gasoline volume on an energy equivalent basis. Given the provisions of the Smith-Jeffords Bill to provide up to $750 Million in grants to MTBE plants to convert, it is likely that a net increase in gasoline volume would occur.

Table A-2: Gasoline Equivalent Volume with a Nationwide MTBE Ban

	Current Production Volume (bbl/day)	Lower Limit of Replaced Volume (bbl/day)	Upper Limit of Replaced Volume (bbl/day)
Captive refinery plants	64,000	54,000	114,000
Propylene Oxide based merchant plants	36,000	31,000	31,000
Ethylene based merchant plants	17,000	14,000	30,000
Merchant (NGL) plants	54,000	0	98,000
Imports (natural gas based)	41,000	30,000	30,000
Total	212,000	128,000	303,000
Change from Current		(84,000)	91,000

This analysis reflects only the changes in MTBE and gasoline hydrocarbon volume. The changes in ethanol volume that go along with this were not quantified in the Pace analysis. However, it is clear that as long as the oxygen mandate in RFG remains in effect and if MTBE were to be banned, then the volume of ethanol produced would have to increase significantly to meet the oxygen requirement. Even without the RFG oxygen mandate, it is likely that a significant amount of ethanol would be used to fulfill the RFG and mobile source air toxics (MSAT) performance requirements. For example, Mathpro, in refinery modeling performed for EPA, projected that 50-65% of California gasoline would contain ethanol if MTBE were banned and the RFG oxygen mandate were waived.

B. Rescinding the 1.0 psi RVP waiver for Ethanol Blended in Conventional Gasoline

Due to its hygroscopic nature it is not possible to ship ethanol blends through the same common carrier fuel distribution system with other petroleum products. Consequently, ethanol is not blended at the refinery into gasoline, but instead is "splash blended" at the terminal, usually as it is loaded into tank trucks. When ethanol is added to gasoline, it results in roughly a 1.0 psi RVP increase in the vapor pressure of the final blend. It is possible to produce a unique sub-RVP grade of gasoline for blending with ethanol downstream to offset this RVP increase, and in fact, that is what is required under the RFG program. Furthermore, some refiners do produce a unique sub-octane grade of gasoline for downstream blending with ethanol already today which could also be made sub-RVP. However, requiring all gasoline blendstock destined for ethanol blending to be distributed separately would place an additional limitation on the distribution system.

Rescinding the 1.0 psi RVP waiver for ethanol blending would, thus require a unique sub-RVP gasoline blendstock for conventional gasoline. Unlike the MTBE ban discussed above, EPA has not conducted studies recently that would quantify the impact of this on overall gasoline supply. However, the analysis is also much less complicated. Based on recent analyses performed in support of our analysis of the boutique fuel issue, we have determined that lowering the RVP of gasoline by 1.0 psi RVP would require the removal of 1.5% of the gasoline in the form of butane. For some refineries, this would require the construction of a new butane-pentane splitter. Since butane contains roughly 85% of the energy content of typical gasoline, on an energy equivalent basis this would represent a 1.3% reduction in the volume of gasoline that is blended with ethanol.

While the amount of butane which needs to be removed from gasoline increases with increased ethanol use, this impact is overwhelmed by the additional volume of ethanol itself. Ethanol is typically blended at a 10 volume percent level (more precisely, at 9.5 volume percent, due to the presence of 5% denaturant). Ethanol contains 60% of the energy per gallon of gasoline. Thus, removing butane to compensate for ethanol's RVP boost only reduces the gasoline equivalent volume gain from ethanol by 22%.

Ethanol blended conventional gasoline currently represents about 7% of total U.S. summertime gasoline consumption, or about 640,000 barrels per day. Thus, about 8000 bbl/day gasoline equivalent of butane would have to be removed from this fuel to compensate for ethanol's RVP boost. However, under a nationwide MTBE ban and some waivers of the RFG oxygen mandate, ethanol use in both RFG and conventional gasoline would likely increase over today's level. Since the RFG performance standards do not grant ethanol an RVP waiver, increased use of ethanol in either fuel would require butane removal. Some of this would be required by current regulation (that in RFG) and some would be required due to the removal of the RVP waiver for conventional gasoline. It is difficult to predict precisely how much ethanol production in general would increase. However, ethanol use could easily double over today's levels (nominally 100,000 bbl/day, or 60,000 bbl/day gasoline equivalent). This could require the removal of as much as 15,000 bbl/day of butane (13,000 bbl/day gasoline equivalent). Thus, the total amount of butane removed could be 22,000 bbl/day gasoline equivalent. However, this is still much lower than the 60,000 bbl/day gasoline equivalent of new gasoline supply associated with the new ethanol production.

C. Existing and Additional Air Toxics Control

It is difficult to quantify the impact on gasoline supply of the existing MSAT standards plus the new air toxics standards which are included in the Smith-Jeffords Bill. The current MSAT standards require refiners to maintain the toxics emission performance of their 1998-2000 RFG and conventional gasoline into the future. In the context of the Smith-Jeffords bill, this means that as MTBE is removed from primarily RFG, refiners producing RFG must maintain their previous toxics emission performance.

In general, this historical performance has been well beyond that required by the RFG regulations. Removing MTBE increases toxics emissions from gasoline, even considering the lower sulfur levels which will be required in the future and lower olefin levels which should accompany the sulfur reductions. Substituting alkylate and iso-octane for MTBE helps, but is still not sufficient to maintain toxics performance. Adding ethanol along with alkylate and iso-octane should be sufficient for most refiners to compensate for MTBE removal.

Another possibility is that most refiners should be able to shift some of their reformate (the gasoline blendstock highest in aromatics and benzene) from RFG to conventional gasoline. This would ease compliance with the MSAT standards for their RFG. However, some refiners are still likely to have to reduce benzene or aromatic levels below current levels. In addition, the MSAT standards are refinery specific and some refiners face tougher standards than others. Some refiners are also more dependent on MTBE use than others currently.

Despite this uncertainty, the impact of the MSAT standards are likely to affect RFG supply more than total gasoline supply. Much less MTBE is used in conventional gasoline today compared to RFG. The levels of sulfur and olefins in conventional gasoline will also be dropping in the near future. Thus, most refiners should find it relatively easy to comply with the MSAT standards for their conventional gasoline even with an MTBE ban. Refiners facing difficulty meeting their MSAT standards for RFG would not decrease total gasoline production, but would shift some of their RFG production to conventional gasoline. Thus, the primary issue with the current MSAT standards is their effect on RFG supply, not total gasoline supply.

Moving to the new toxics performance standards in the Smith-Jeffords bill, as we understand them, they would be imposed in addition to the current MSAT standards. As a result, refiners with cleaner than average historic RFG would be constrained primarily by the MSAT standards, while refiners with poorer than average historic RFG toxics performance would be held to a new PADD average toxics standard.

We have not analyzed the impact of a regional toxics standard of this type, particularly in conjunction with the MSAT standards. However, as was the case with the MSAT standards themselves, the impact of the regional toxics standards would be to make it relatively more difficult to produce RFG than conventional gasoline. Total gasoline supply would probably be little affected, but RFG supply could be affected. More analysis is needed before any quantitative estimates could be made.

D. Overall Impact

Due to our current inability to quantify the impact of the current and new toxics emission requirements on gasoline supply, we cannot provide an overall estimate of the impact of the bill on gasoline supply. However, the combination of alkylate and iso-octane production from current MTBE plants, plus the likely increase in ethanol use should more than compensate for the loss of MTBE volume. Thus, based on this first order analysis, total gasoline production capacity
could actually increase. The toxics standards primarily affect RFG production relative to conventional gasoline production. Thus, whether RFG production increases must await further analysis. However, there appears to be a significant probability that total gasoline production capacity would increase.

1. Pace Consultants, Inc., "Economic Analysis of U.S. MTBE Production Under an MTBE Ban," May 2001.